Potential Paths for Male-mediated Gene Flow between the NCDE and GYE Grizzly Bear Populations



Christopher Peck, Frank T. van Manen, Cecily Costello, Mark Haroldson, Lisa Landenburger, Lori Roberts, Daniel Bjornlie, and Richard Mace

Photo: Jake Davis

Acknowledgments

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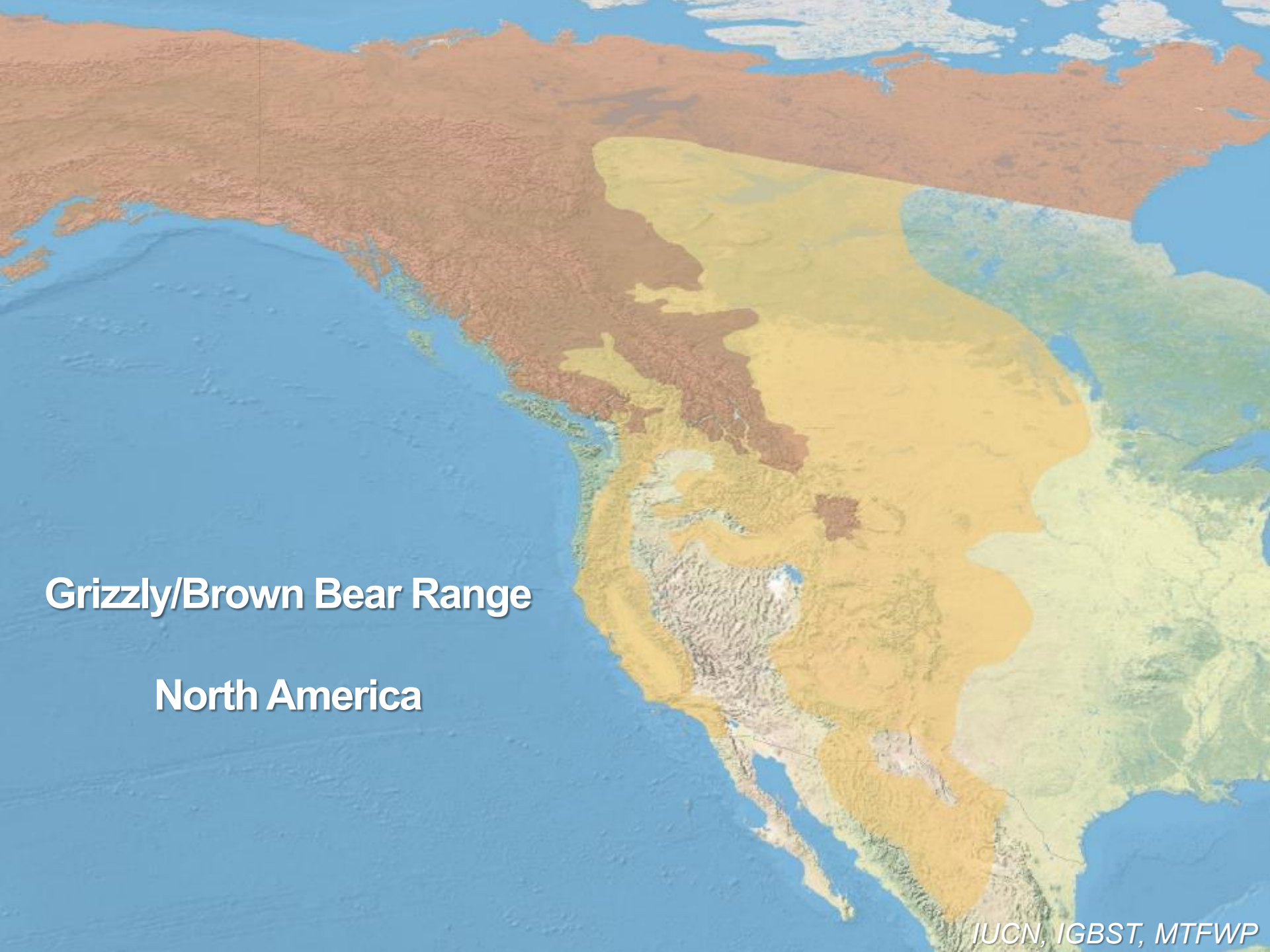
Blackfeet Nation
Confederates Salish and Kootenai Tribes
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Montana Department of Fish, Wildlife and Parks
National Park Service
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Wind River Fish and Game-Eastern Shoshone & Northern Arapaho Tribes
Wyoming Game and Fish Department

Chris Servheen, Justin Gude, Robert Inman, Dave Gustine

Overview

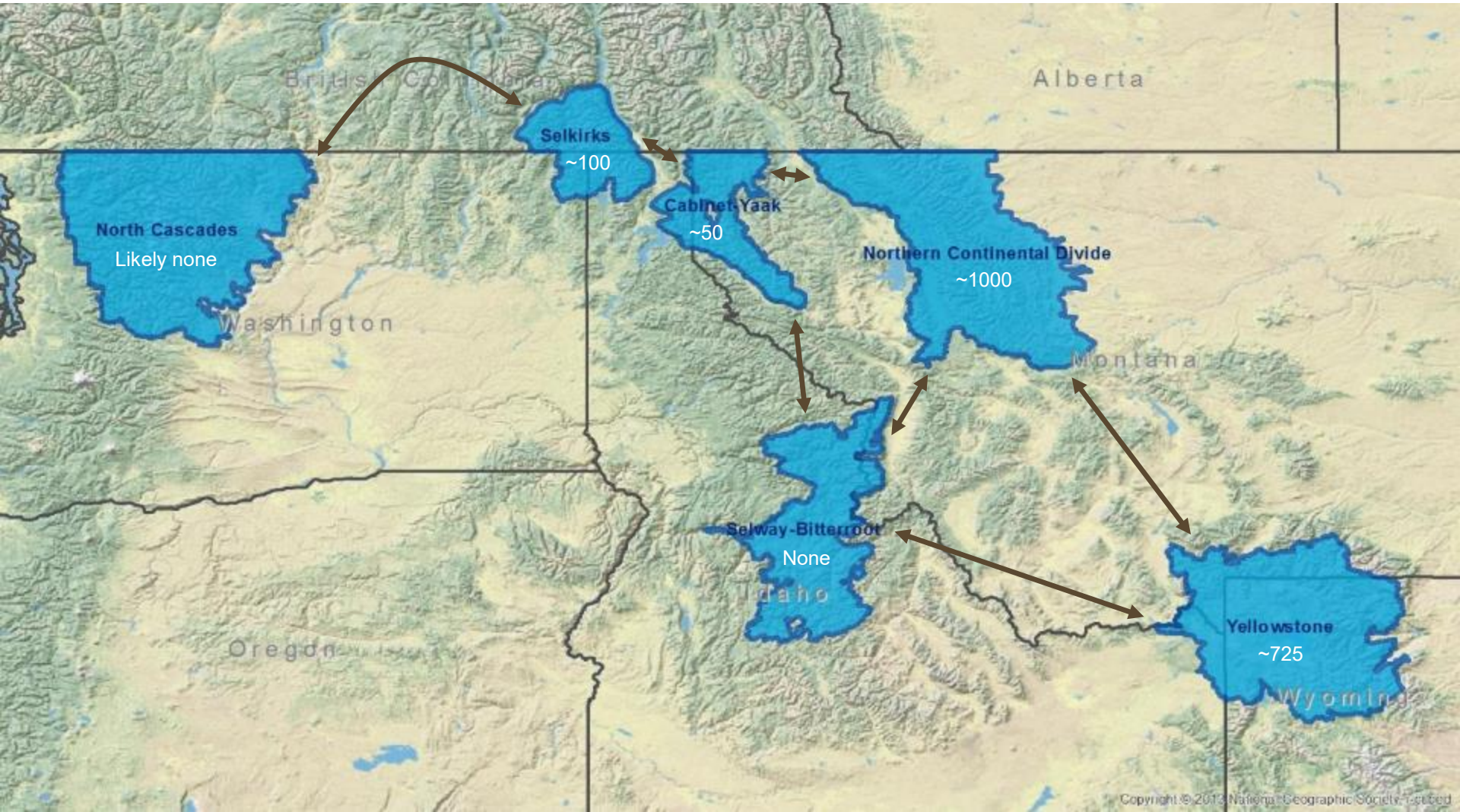
- Background
- Approach
- From science to management




Grizzly/Brown Bear Range
North America
IUCN, IGBST, MTFWP

Federal Recovery Zones

- Established in Recovery Plans (1982, 1993)



Federal Recovery Zones

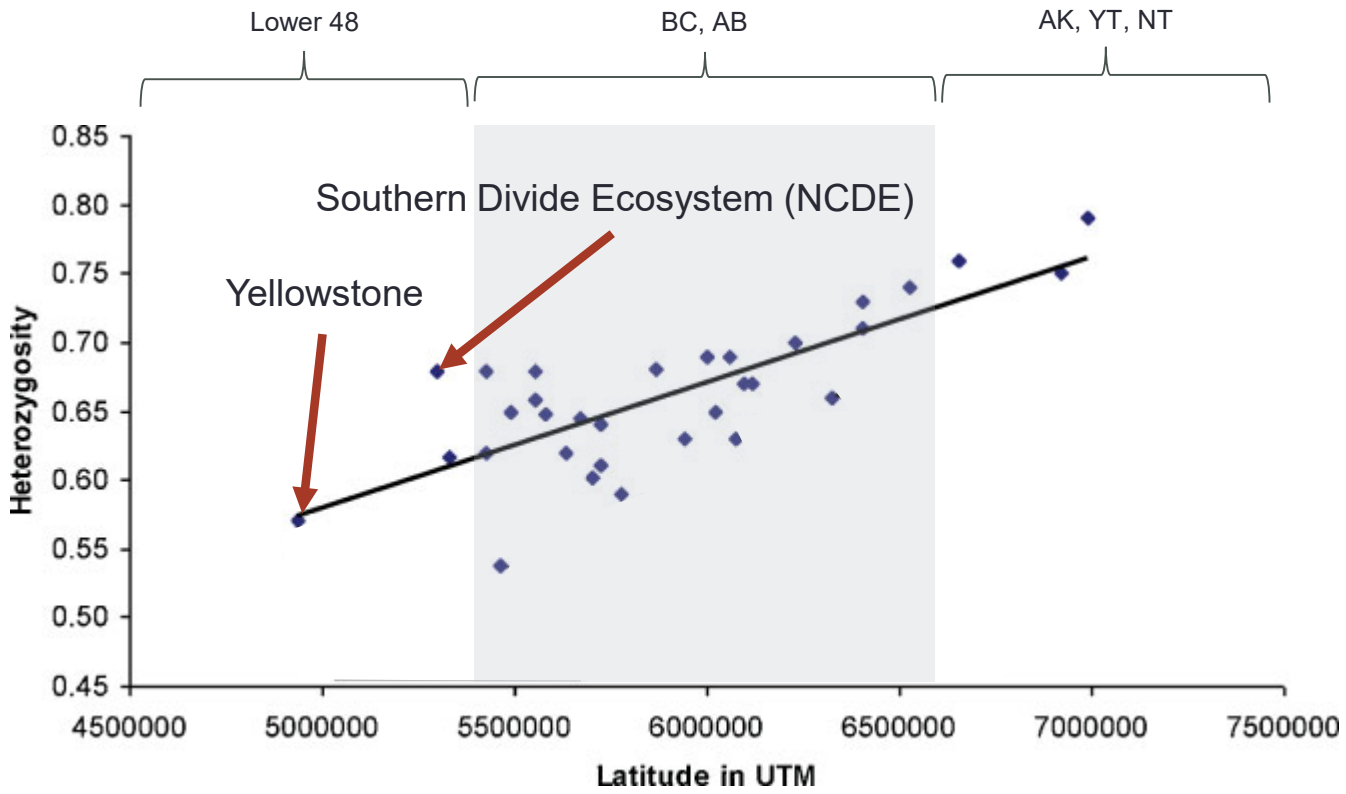
- Established in Recovery Plans (1982, 1993)



Information need

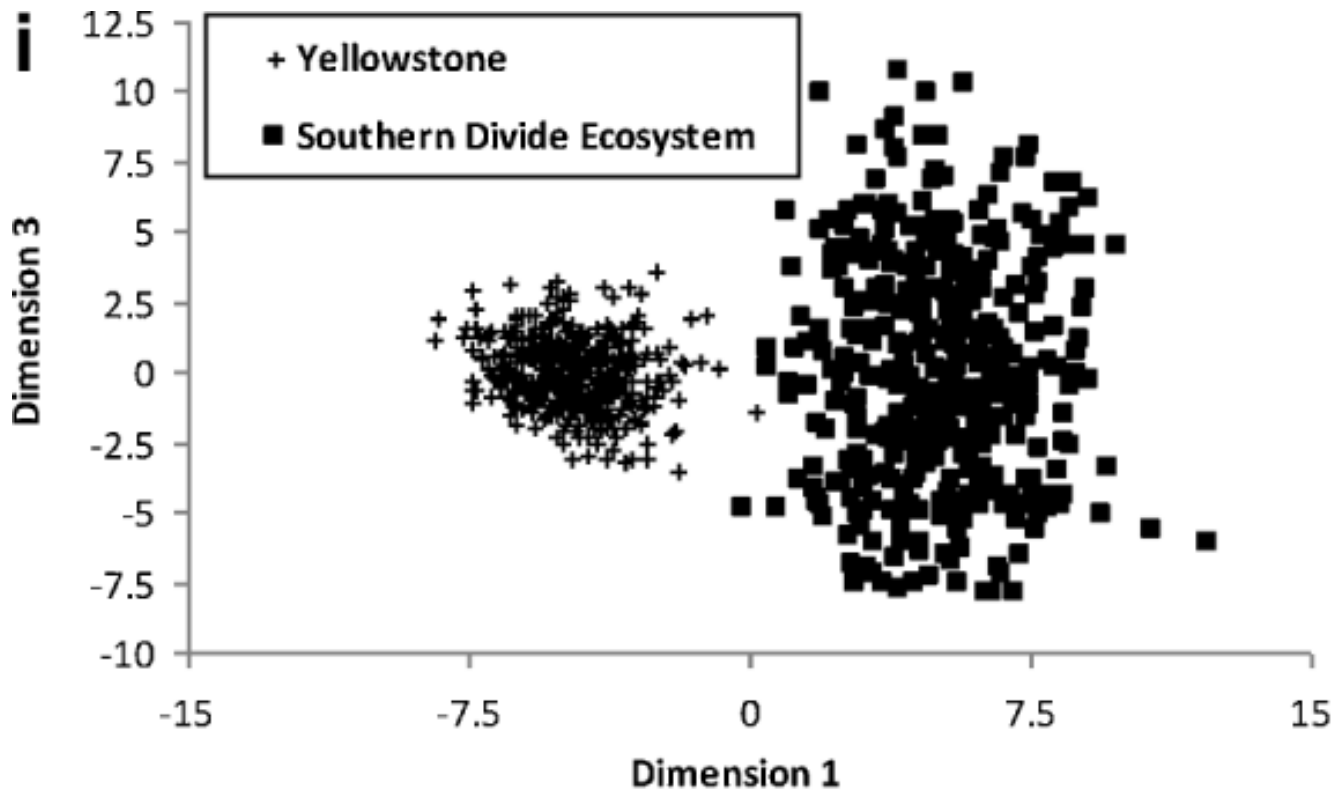
- Identify paths between NCDE and GYE with habitat conditions conducive to male dispersal
- Make predictions based on grizzly bear location data and observed habitat selection
- Explore trade-off between optimal and exploratory paths

Genetic diversity



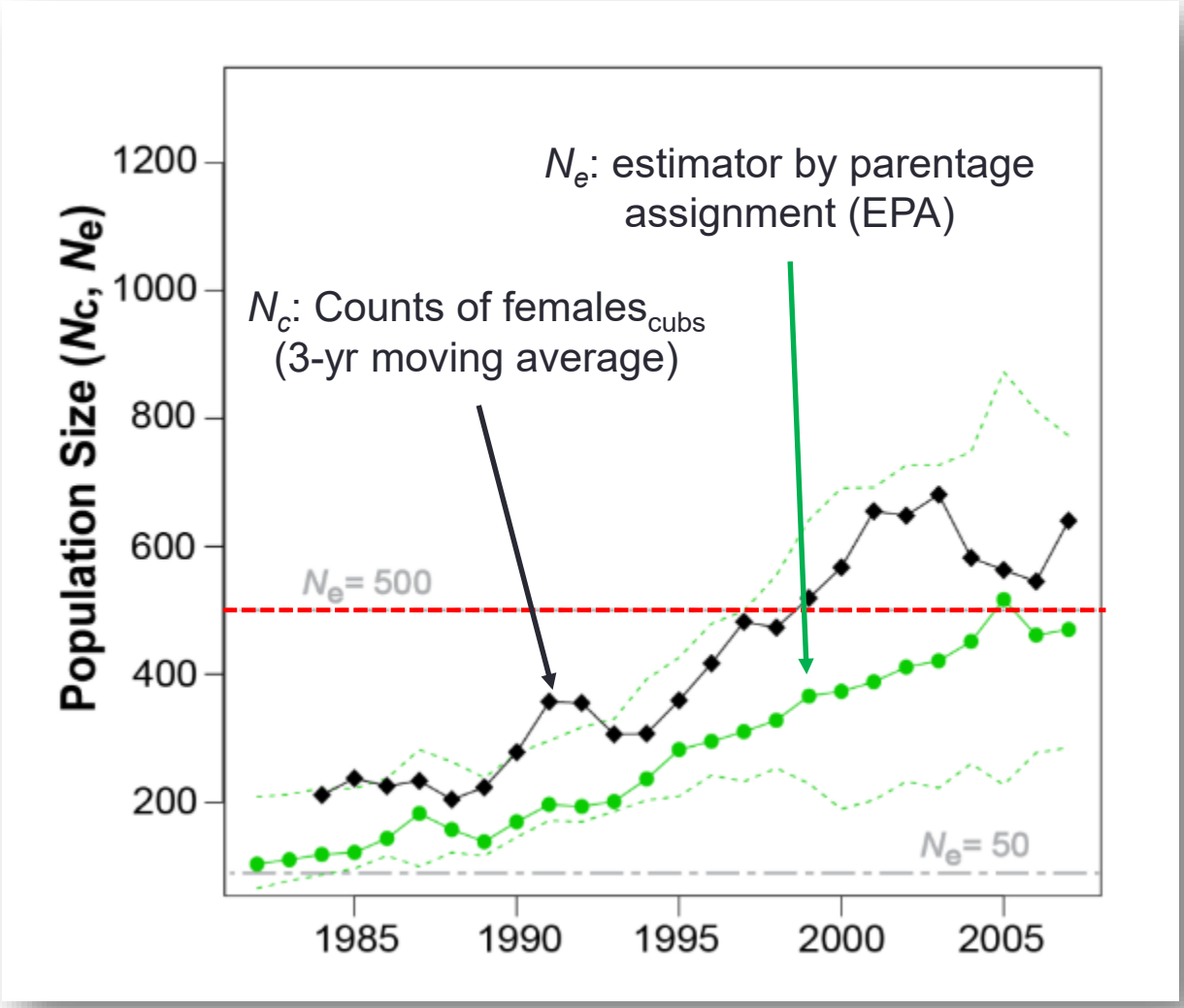
Proctor et al. 2012

Genetic connectivity



Proctor et al. 2012

Yellowstone effective population size

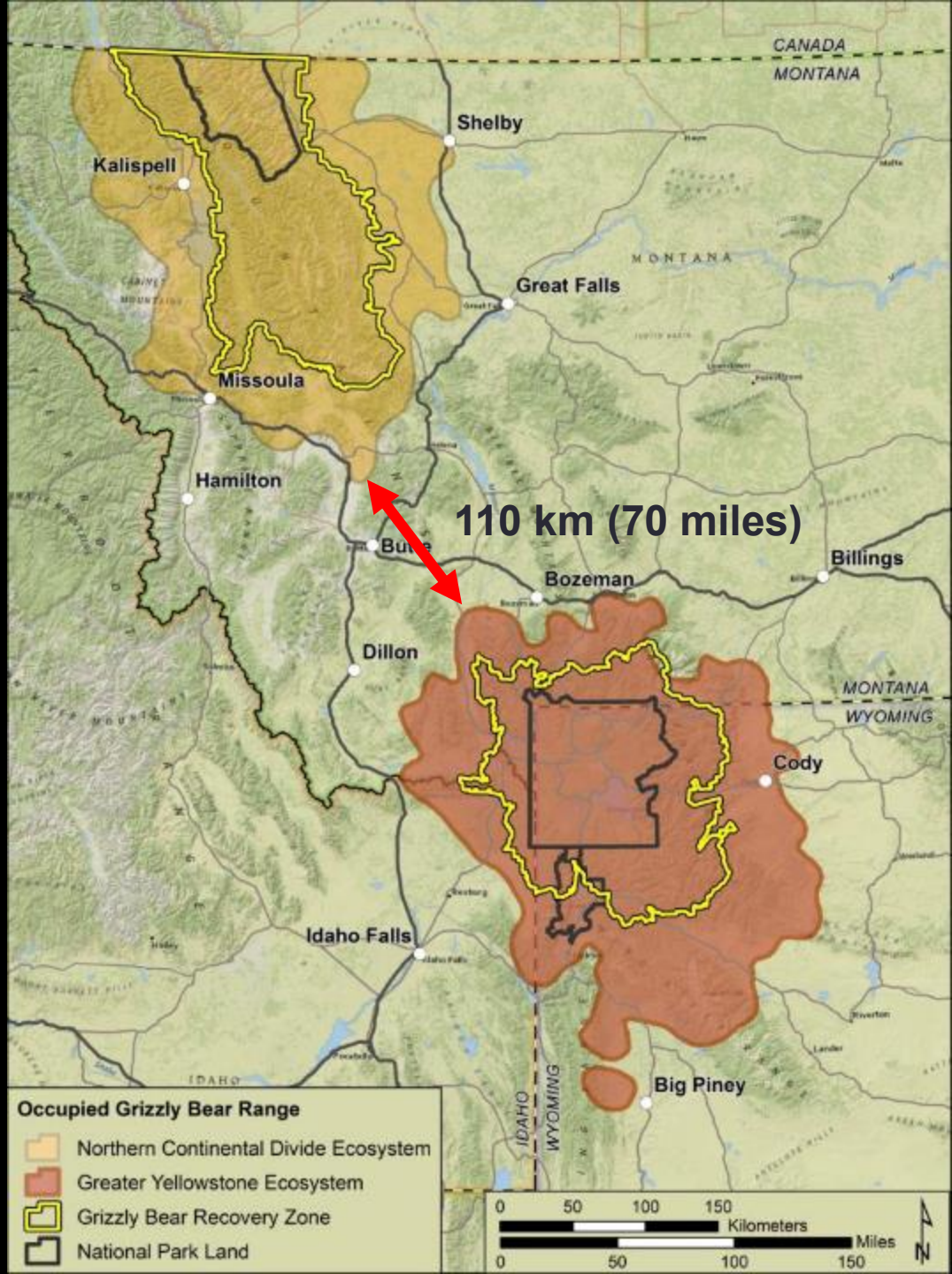


Kamath et al. (2015)

Occupied Range

Northern Continental Divide
55,200 km^2 (2004-2014 data)

Greater Yellowstone
58,314 km^2 (2000-2014 data)



Costello et al. 2016, Bjornlie et al. 2014

Genetic connectivity

- Long-term management goal for Montana Fish, Wildlife and Parks - natural movement favored over translocation of bears between ecosystems

- Public interest - genetic connectivity major concern among thousands of public comments about delisting



Study Approach : Model movements based on data from GPS-collared bears

- Sample of research-monitored bears from both ecosystems

Photo: IGBST/van Manen

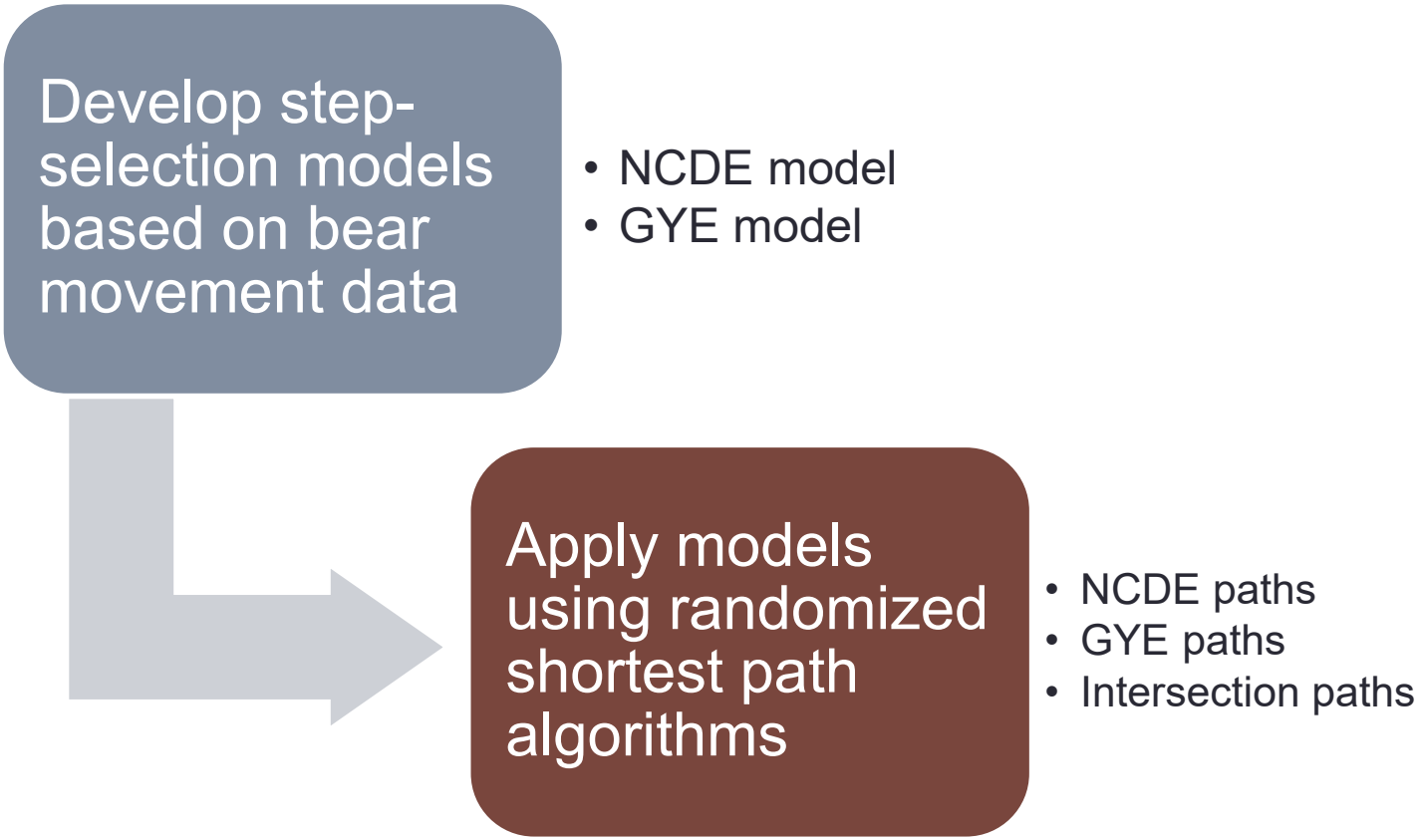
Study Approach : Model movements based on data from GPS-collared bears

- Additional bears monitored for conflict management

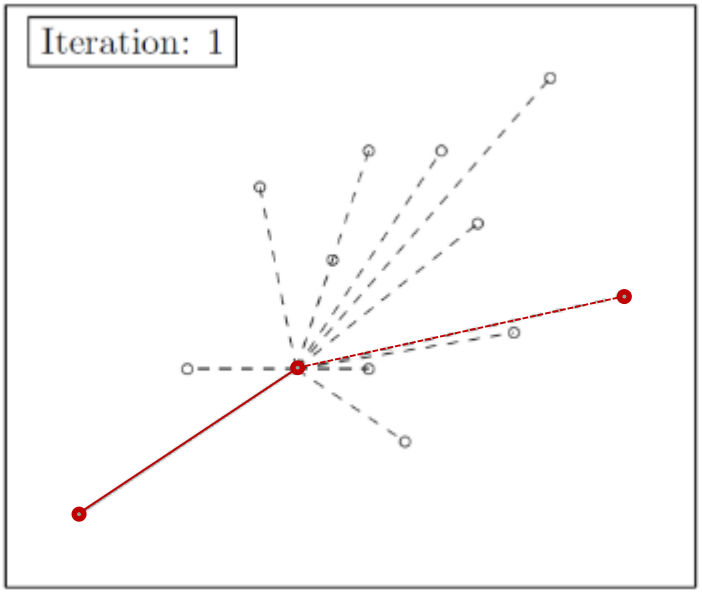
Data

- GPS data from males ≥2 years old
  - 124 individuals (199 unique bear-years)
  - 126,000 steps involving movements >100 m
- Spatial data layers (300-m resolution)
  - Distance to forest edge
  - Natural contagion
  - NDVI (greenness)
  - Distance to rivers and/or streams *
  - Elevation
  - Ruggedness
  - Primary and/or secondary roads (density or distance) *
  - Home density

Analytical approach



Step-selection functions

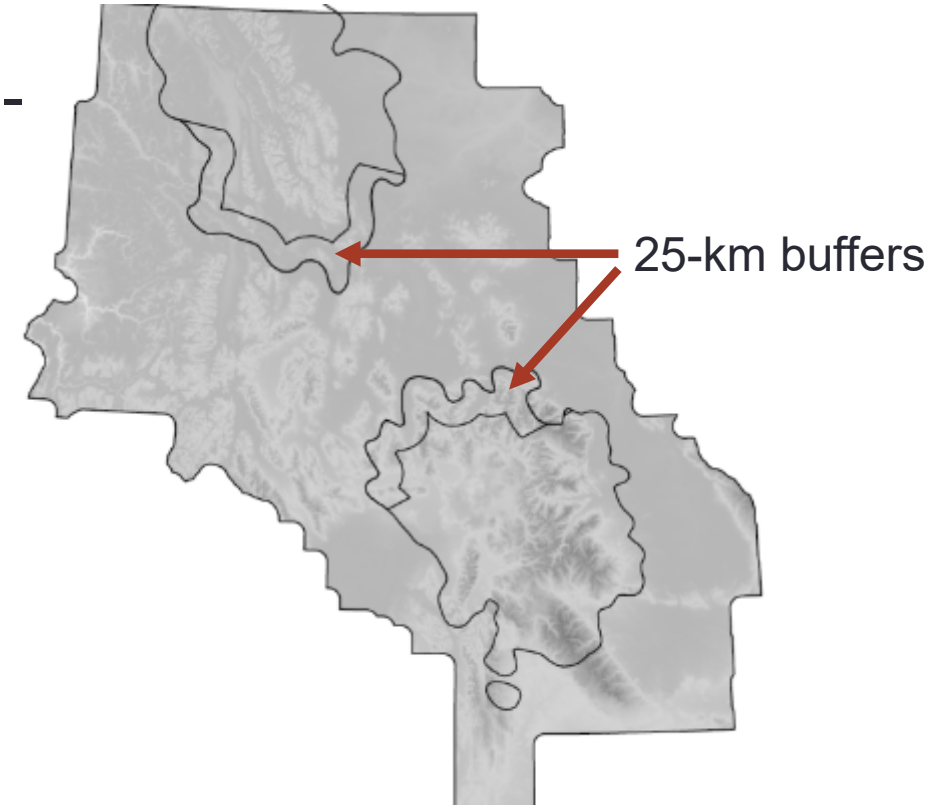


- Iterative process involving turn angles and step-lengths
- Model selection with AIC_c
- 5-fold cross-validation, repeated 100 times

  (Median Spearman rank correlations: NCDE = 0.94, GYE = 0.86)

Randomized shortest paths (RSP)

- Resistance surface from step-selection model
- 100 random start and end nodes
- Calculate average number of net passages in grid cells



- 3 levels of Θ (theta) = trade-off between exploration and optimal exploitation of landscape

Paths



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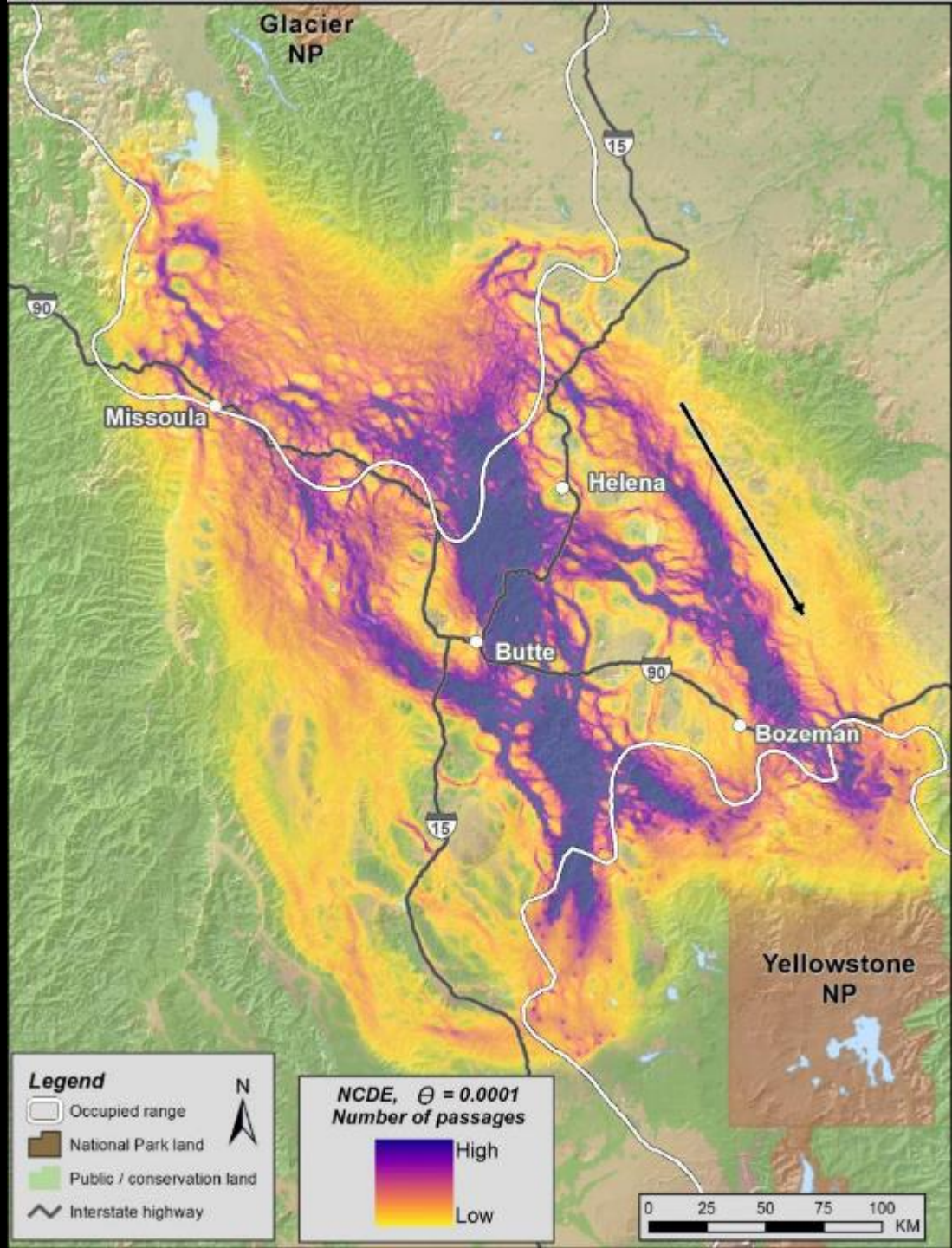
Photo: Jake Davis

Randomized Shortest Paths

Northern Continental Divide

to

Yellowstone

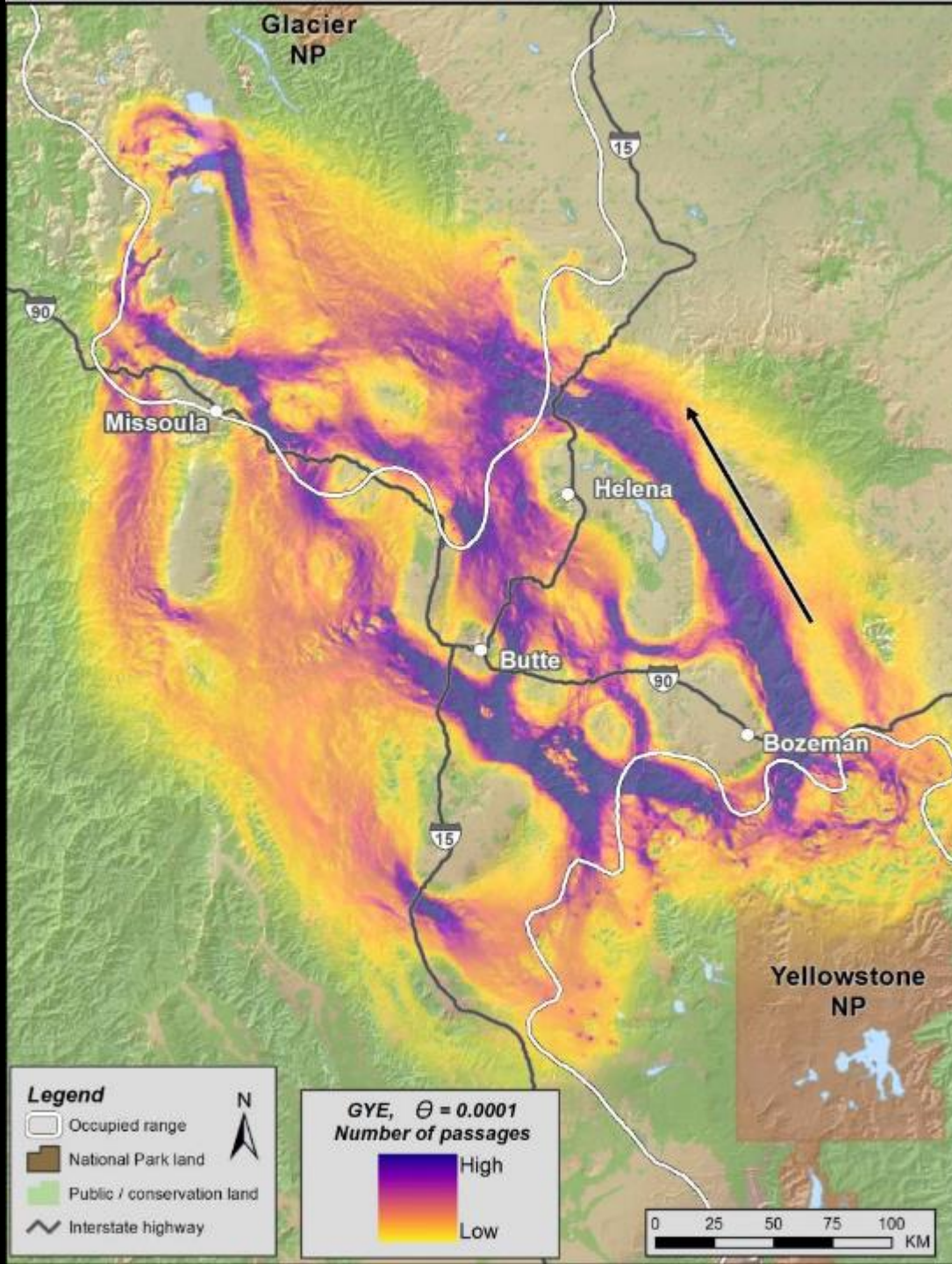


Randomized Shortest Paths

Yellowstone

to

Northern Continental Divide



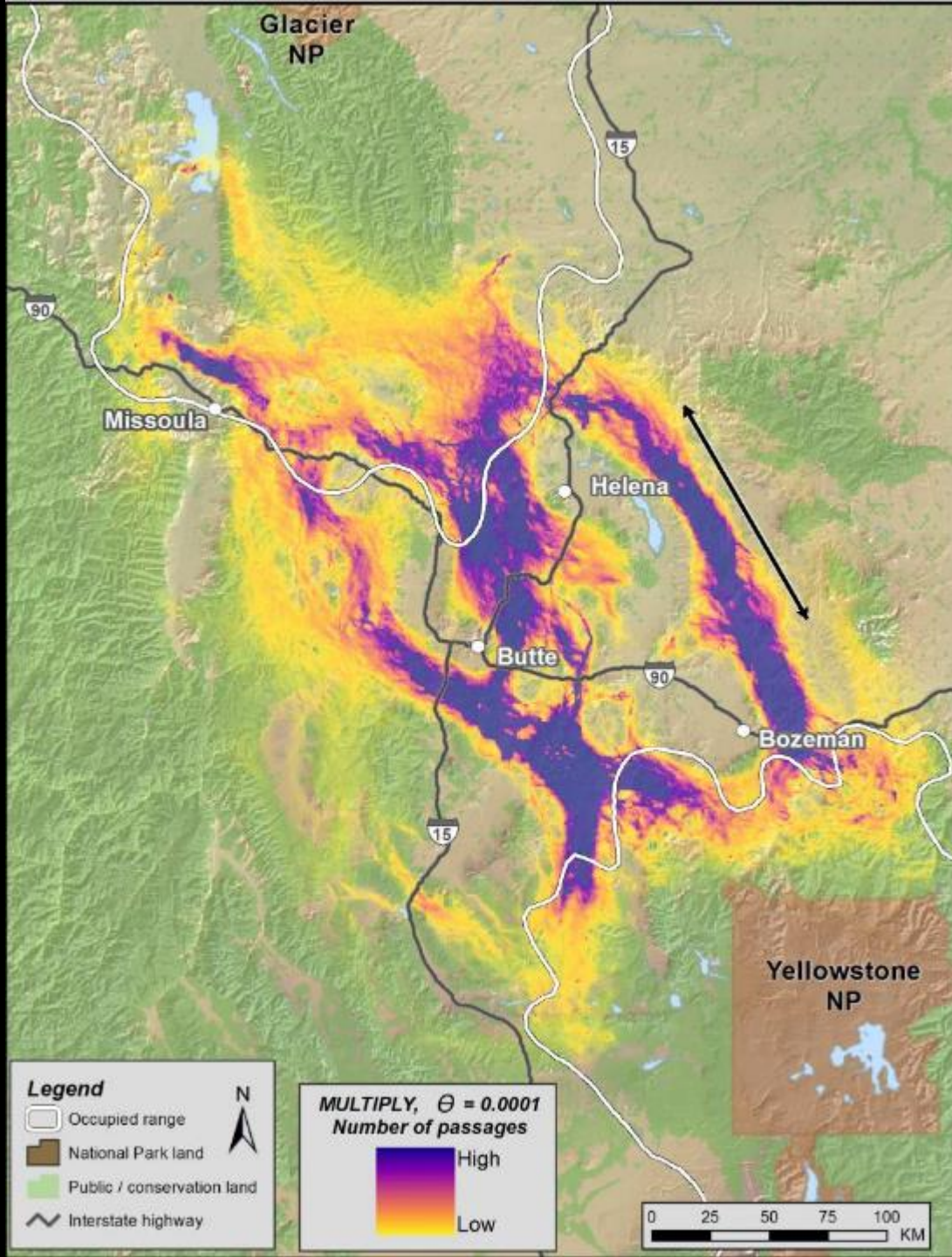
Randomized Shortest Paths

Intersect of paths between

Northern Continental Divide

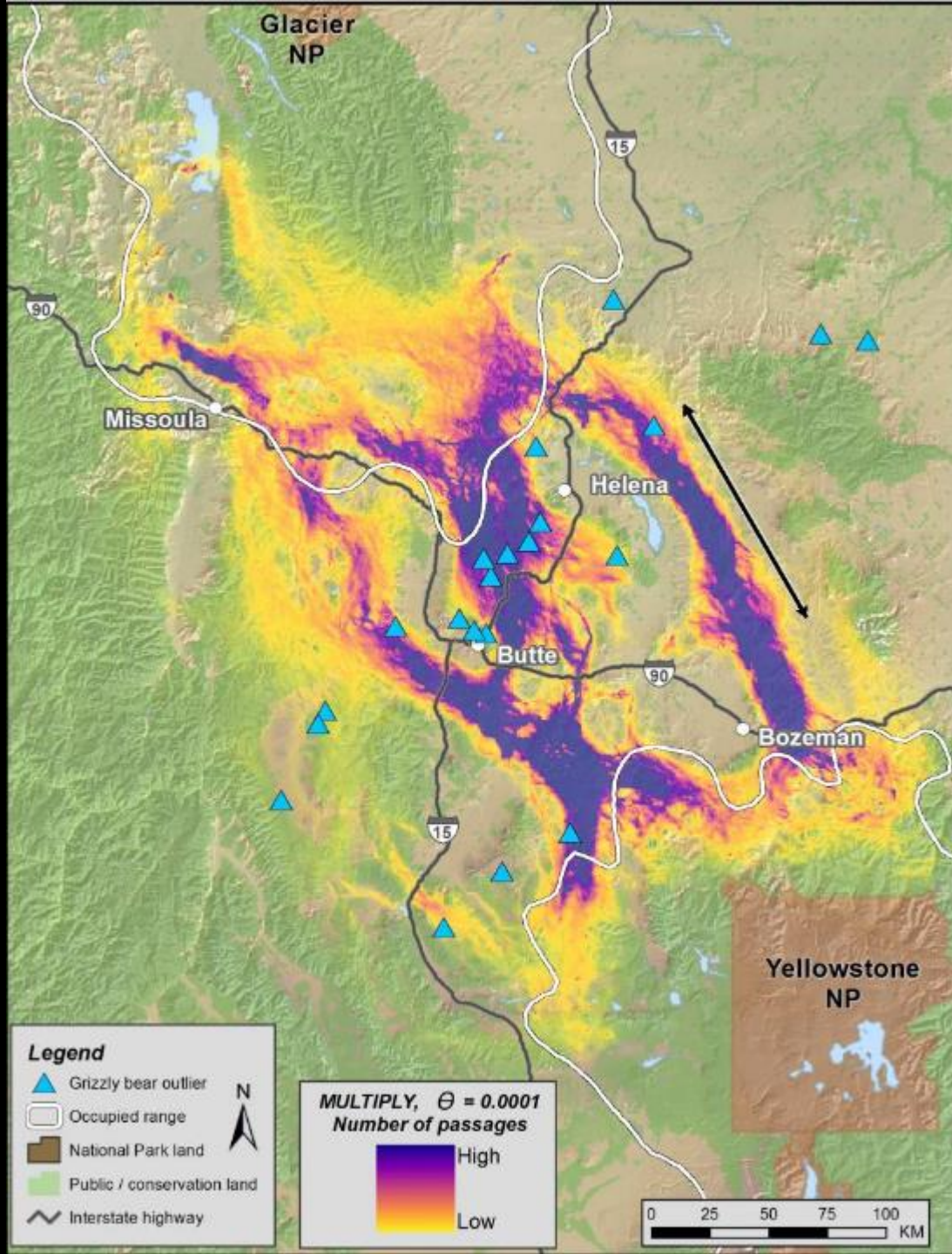
and

Yellowstone



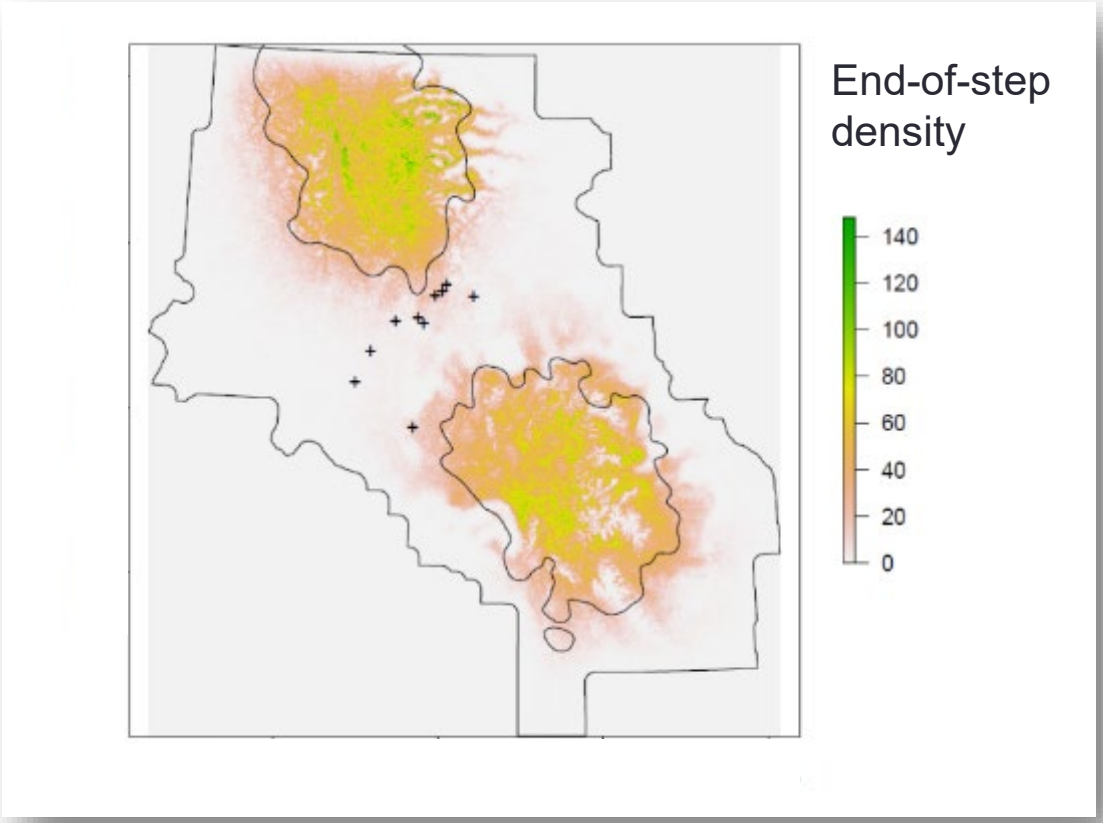
Ad-hoc validation

- 21 verified records
- Mortalities, remote camera, tracks, or DNA
- 1998-2017
- 87% in last 4 years
- High correspondence with path predictions: quantiles = 0.75 to 0.87



Rare events

- no successful “immigration event” for 20,000 simulations of correlated random walks



Informing management

- Target groups: agency managers, NGOs, public
- Identify and prioritize conservation measures
  - Conservation easements and land purchases
  - Mitigation of potential barriers (e.g., highways)
  - Proactive attractant management
  - Education and information programs
- Path layers available online

Informing management

Montana Department of Fish, Wildlife & Parks
Grizzly Bear Management Goal

"To manage for a recovered grizzly bear population in western Montana and to provide for a continuing expansion of that population into areas that are *biologically suitable* and *socially acceptable*.

Conservation on private land

- NCDE Recovery Zone
  - 91% Public land
- GYE Recovery Zone
  - 98% public land
- Connectivity area
  - 49% public land



Conservation on private land

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Cheetahs seek refuge on farmland, complicating conservation

By Dana Kobilinsky

Posted on December 26, 2017



A female cheetah uses a high vantage point to look for potential prey. ©Stéphanie Périquet

"Farmers are the future of cheetahs, not their enemy."

Florian Weise, lead author



PeerJ

The distribution and numbers of cheetah (*Acinonyx jubatus*) in southern Africa

Florian J. Weise[1,2,3,*], Varsha Vijay[3,4,*], Andrew P. Jacobson[5,6], Rebecca F. Schoonover[5,6], Rosemary J. Groom[7,8,11], Jane Horgan[3,6], Derek Keeping[9], Rebecca Klein[3,6], Kelly Marnewick[3,8], Glyn Maude[3,10], Jörg Melzheimer[11], Gus Mills[12,13], Vincent van der Merwe[3,8], Esther van der Meer[3,13], Rudie J. van Vuuren[3,14], Bettina Wachter[11] and Stuart L. Pimm[3,6]

[1] CLAWS Conservancy, Worcester, MA, United States of America
[2] Center for Wildlife Management, University of Pretoria, Pretoria, South Africa
[3] Big Cats Initiative, National Geographic Society, Washington, D.C., United States of America
[4] Nicholas School of the Environment, Duke University, Durham, NC, United States of America
[5] Range Wide Conservation Program for Cheetah and African Wild Dogs, The Zoological Society of London, London, United Kingdom
[6] Cheetah Conservation Botswana, Gaborone, Botswana
[7] Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada
[8] Endangered Wildlife Trust, Johannesburg, South Africa
[9] Kalahari Research and Conservation, Maun, Botswana
[10] Department of Conservation and Research, Denver Zoological Foundation, Denver, CO, United States of America
[11] Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany
[12] Lewis Foundation, South Africa
[13] Cheetah Conservation Project Zimbabwe, Victoria Falls, Zimbabwe
[14] Nin'an ku ai Foundation, Windhoek, Namibia
[15] African Wildlife Conservation Fund, Chinhoyi Ranch, Save Valley Conservancy, Zimbabwe
* These authors contributed equally to this work.

ABSTRACT

Assessing the numbers and distribution of threatened species is a central challenge in conservation, often made difficult because the species of concern are rare and elusive. For some predators, this may be compounded by their being sparsely distributed over large areas. Such is the case with the cheetah *Acinonyx jubatus*. The IUCN Red List process solicits comments, is democratic, transparent, widely-used, and has recently assessed the species. Here, we present additional methods to that process and provide quantitative approaches that may afford greater detail and a benchmark against which to compare future assessments. The cheetah poses challenges, but also affords unique opportunities. It is photogenic, allowing the compilation of thousands of crowd-sourced data. It is also persecuted for killing livestock, enabling estimation of local population densities from the numbers persecuted. Documented instances of persecution in areas with known human and livestock density mean that these data can provide an estimate of where the species may or may not occur in areas without observational data. Compilations of extensive telemetry data coupled with nearly 20,000 additional observations from 39 sources show that free-ranging cheetahs were present across approximately 789,700 km² of Namibia, Botswana, South Africa, and Zimbabwe (56%, 22%, 12% and 10% respectively) from 2010 to 2016, with an estimated adult

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Corresponding author
Stuart L. Pimm, stuart.pimm@duke.edu

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Additional Information and Declarations can be found on page 23

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GIS layers - https://www.sciencebase.gov/catalog/
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